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Sanitation in the trenches

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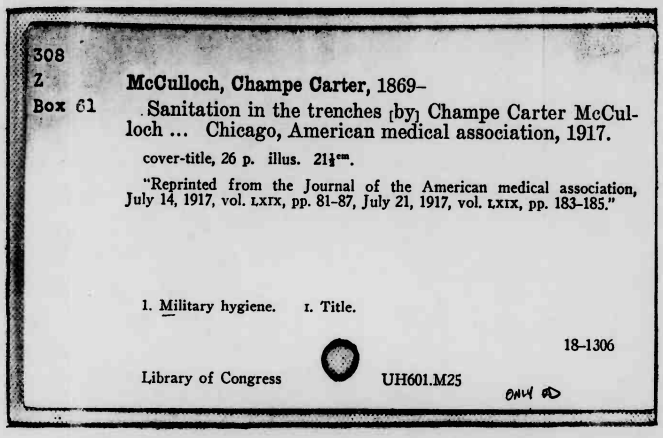

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CHAMPE CARTER McCULLOCH, M.D.
Lieutenant-Colonel, United States Army; Professor of Military Hygiene, Army Medical School
WASHINGTON, D. C.

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SANITATION IN THE TRENCHES

CHAMPE CARTER McCULLOCH, M.D.
Lieutenant-Colonel, United States Army; Professor of Military Hygiene, Army Medical School,
WASHINGTON, D. C.

From professional friends in the medical centers who are most in touch with the younger physicians I learn that there is a great demand among the latter for medicomilitary literature concerning the present war. Naturally, planning to take up at an early date the duties of what they are beginning to realize is practically a specialty to which our medical colleges have heretofore given no attention, as intelligent professional men and as patriotic citizens they are eager for information that will enable them competently to fill the military offices to which they shortly expect appointment, and to "do their bit," however small, in an adequate and self-satisfying way.

At present, unfortunately, there is a great lack of literature along these lines. Physicians abroad, both at home and afield, are all more or less engaged in the work of the war and have had little time to write; and what has been written, owing to evident difficulties in the transportation of mail, is not always received on this side of the water. Fortunately for our present purposes, this matter is not vital. I have been informed by competent observers from the western front that the German sanitary methods and results are far behind those of the British and French; indeed, there seems to be some evidence that the medical department of the German army, owing probably to the use of antiquated administrative methods, practically broke down in the early part of the war.

Realizing this literary dearth, the medical section of the Advisory Committee of National Defense has patriotically decided to have published at as early a date as practicable a series of pocket handbooks designed for easy use in the field, and treating of those

subjects that are most essential in this connection. The series will consist of English manuals, revised and up to date, French translations, and short monographs on special subjects, the latter written mostly by some of our own physicians and surgeons who have already seen service abroad. This plan, when effectuated, will no doubt take care of one of the most important phases of the matter of medical preparedness for the war.

Pending the publication of these books, which will probably require several months for completion, the want can be partially filled by short journal articles on some of the more important subjects. Of these the most urgent is that of camp sanitation. I regret extremely that none of our many competent army sanitarians has taken up this task. It may perhaps be a case of "angels fearing to tread," owing to the dry nature of the subject and the great difficulty of making its treatment interesting. However, at the risk of subjecting myself to this criticism, I have felt constrained, mainly because of the reticence of more able pens, to enter the breach. Elsewhere[1] I have dealt briefly with what may be called the general principles of military hygiene, which apply in this war just as forcibly as in previous ones. This paper is simply an effort to bring the matter up to date by a short description of the particular methods that the peculiar environment abroad has developed in modern trench warfare. I have been greatly aided in this design by having had the good fortune to hear the interesting lectures of Colonel Goodwin of the British mission to the United States covering this subject, and by the recent issue from the press of a revised American edition of Major Lelean's "Sanitation in War."[2] Anything that may prove of value in this paper is really due to these two authors. In fact, I make no claim whatever to originality, unless, indeed, it may be originality to endeavor to arouse interest in a very dry subject or to try to pick the essentials of the subject out of a large mass of details. This would be better, indeed, than originality for our present purposes. It would be a big start toward the solution of a problem that has always caused us serious trouble in our previous wars, leading

1. McCulloch, C. C.: Med. Rec., New York, June 2, 1917.
2. I am indebted to the extreme courtesy of Messrs. P. Blakiston's Son & Co. of Philadelphia for permission to use the illustrations accompanying this article.

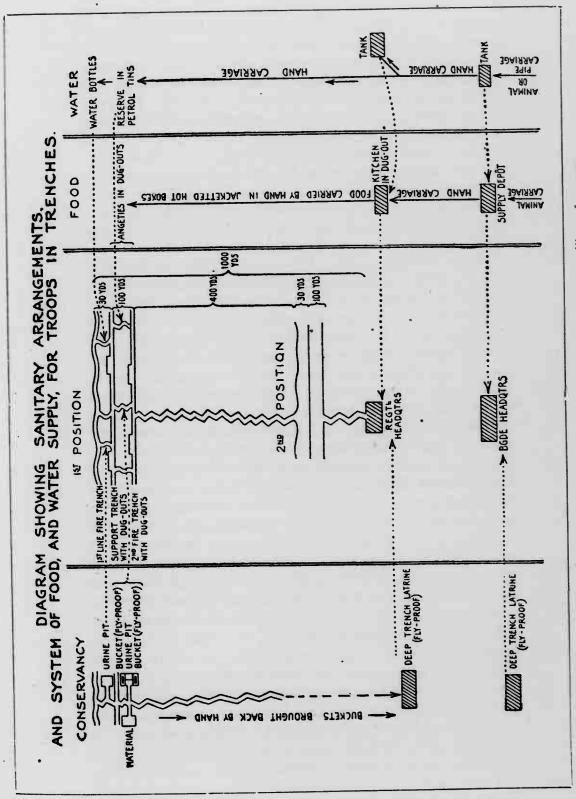

Fig. 1.—Plan of arrangements for food, water, and the handling of excreta.

to scandals and investigating committees, and "the tumult and the shouting" of popular disapproval and newspaper notoriety. In spite of much natural optimism I have, however, little hope of accomplishing the end aimed at, for are there not already in the air the mutterings of approaching storms, and have not the dreaded criticisms in fact already begun? For my part, I merely feel the "call" to expound the doctrine as it has been revealed to me.

The French ideas on field sanitation have been ably and interestingly presented by Andre Tournade in "La pratique de l'hygiène en campagne." (1916). However, I do not find in this work what I consider any special improvements on the British methods herein outlined.

Major Vedder of the Army Medical Corps has prepared a little handbook entitled "Sanitation for Medical Officers" that will be published at an early date.[3] This with Lelean's excellent book, and, for reference purposes, the last (second) edition of Havard's "Military Hygiene," will cover, in my opinion, all the literature on sanitation necessary for the physician in the field in the coming war. Short orders and circulars on special subjects are issued from time to time by the War Department, and these will serve to keep one entirely up to date along these lines.

To take up the consideration of our subject: In the area behind the front there has been no particular departure from our old established sanitary methods; the general principles, indeed, remain the same in all war areas. In general hospitals and at the base, these being usually situated in towns of some size, systems of water carriage and modern sewage disposal make our sanitary labors light. Fixed incinerators for general refuse are easily established and maintained.

In case no such systems exist, they are installed as necessary. The simple range style of water closet, which was used with excellent results for the workmen on the Panama canal, offers an easy solution of this particular problem, and the same arrangement is applicable to permanent camps. This device is, in effect, an iron trough, with water and sewer connections, that flushes itself automatically at regular intervals. Its chief advantage is in its economical installation and operation as compared with the customary watercloset fixtures.

3. Under the authority of the Surgeon General of the Army, and of the Council of National Defense.

In semipermanent and large standing camps, when it is impracticable to install sewerage systems, it has been found by experience in our army that the deep trench latrine system with fly-proof box covers, in connection with improvised incinerators for refuse, if adequately administered, can be made to meet the sanitary situation satisfactorily. The urine soakage pit, described below, makes a desirable addition to this plan. Another improvement, in connection with latrines, is the use of a barrel, conveniently situated, containing cresol solution for hand disinfection, and provided with a conspicuous label directing that the men wash their hands after using the sink.

This seems a good place to state that the only really safe and effective way of administering these field latrines is to have a sentry posted over them whose duty it is to look out for the details of their operation, particularly with reference to the fly-proofing.

In the European system of billeting troops in villages, it is customary to make the best of existing facilities. The most common arrangement is that which we found in Cuba in 1898; that is, cess pits under the individual houses, which are pumped out from time to time by some form of suction apparatus.

It goes without saying that all our field methods, and in particular those concerned with conservancy, require for the accomplishment of real results the strictest sanitary supervision and inspection.

Experience has shown that at the front proper certain modifications of our usual conservancy plans are advisable, which are in one way a reversion to earlier and discarded methods, although in others they conform much better to the local conditions. The essential thing is that with care we get results, the "acid test" of the success of any kind of campaign.

The vital things in military sanitation are (1) food, (2) water, (3) conservancy, (4) personal habits, and (5) the prevention of special diseases.

I. THE FOOD SUPPLY

One of the most noticeable developments of the European war in this connection has been the increased

vogue of the traveling kitchen or field cooker in the zone of advance. According to Lelean, "that now in use is of the 'heat retaining' type which gives en

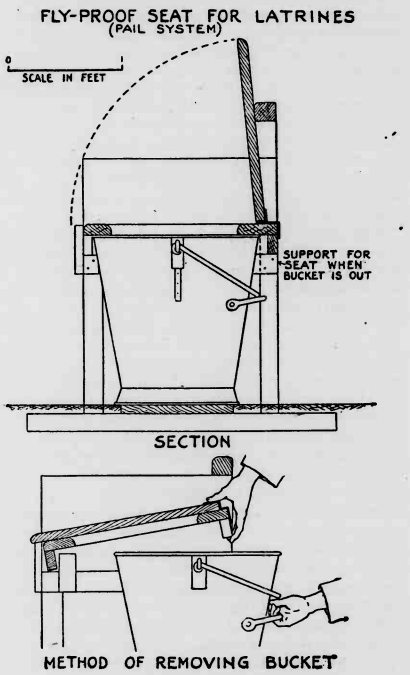

Fig. 2.—Fly-proof container for latrine pail.

route no smoke which might draw the enemy's fire. It consists of ovens and hot-jacketed boilers arranged around a central furnace, all contained in the body of

the wagon. The limber contains hot-jacketed receptacles, compartments for rations, utensils, food, etc. It can be detached from the body and, being drawn by one horse, is used for food distribution while the body continues cooking. The whole is drawn by two horses, weighs 24 hundredweight, and cooks for 250 men and their officers." On the march it travels with the first line of transport. From these, or from improvised dugouts (Fig. 1) conveniently situated, food is carried by hand in jacketed boxes and covered tins, through the communication trenches to the troops at the front.

A lesson taught us by experience in the Spanish and Boer Wars, as well as by the discoveries of modern bacteriology, is the importance, from a hygienic standpoint, of avoiding "carriers" in any work that concerns the preparation and distribution of food. The medical history of all men detailed into company kitchens should therefore be investigated, coupled with a careful examination of their actual physical condition. Much sickness, especially the intestinal varieties of disease, may often be avoided in this way.

It has been found abroad that our former plan of screening entire kitchens can be improved on by substituting the screening of the food itself, the fly nuisance being better controlled in actual practice in the latter way. Screened cupboards or safes are used for meat, bread, jam, opened tins or other foods that attract flies, and eating utensils are kept covered. Simple muslin squares, weighted at the corners, can be used for much of this work. Covered barrels or tins are employed for the bestowal of refuse, previous to incineration.

Grease in the sullage water resulting from cooking processes is often quite a nuisance, and a simple method of getting rid of it in camp has been devised in the form of a sort of grease trap. A box is filled to a depth of several inches with clean sand, and a vertical partition placed in the middle which dips down at its lower edge for a couple of inches into the sand, making two compartments. The sullage introduced into one side filters through into the other under the partition, leaving most of the grease behind. The effluent is handled as described below for urine. The process works better if gross particles are first removed from the water by running it through a kero-

sene tin loosely filled with hay. The filtering materials are renewed as required when they become clogged.

II. WATER SUPPLIES

A glance at the diagram (Fig. 1) will show the method of supplying drinking water to the troops in

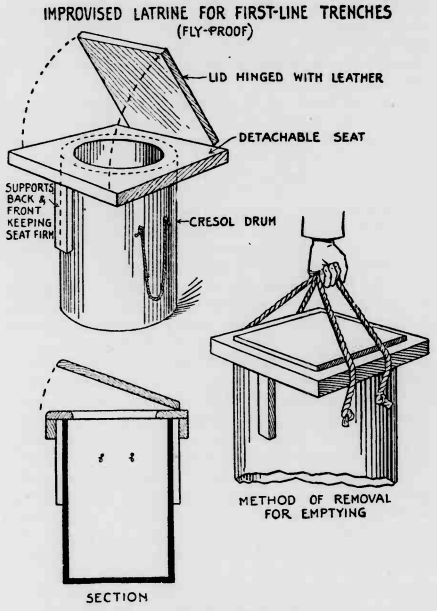

Fig. 3.—Fly-proof cover for latrine pail.

the trenches. Water tanks are set up at distances of 1,000 yards or more from the first line trenches, obtaining their supplies from pipes when such a system is available, or otherwise from horse-drawn water carts.

The water in the tanks is, when necessary, sterilized by the hypochlorite process, which seems to act as a bactericide by oxidation with oxygen liberated from the hypochlorite rather than by free chlorin. One part of available chlorin per million acting for half an hour is an effective dose, and this is supplied by two gm. of bleaching powder to the ordinary water cart containing 110 gallons. The process requires supervision and examination of the chemical from time to time by titration methods to see that it has not lost its strength. From the tanks the water is carried in kerosene tins by hand through the communicating trenches, and stored as a reserve in dugouts back of the support trench. The soldiers' water bottles are filled there. Cavalry soldiers are supplied with sterilizing tablets for use in the bottles themselves.

III. DISPOSITION OF EXCRETA

The conditions to be met abroad with respect to this point are practically those of a siege. Various methods were tried in the earlier part of the war. One of the simplest was a sort of reversion to the old stink-pot idea of the Chinese; that is, the material, collected in buckets, was thrown over into the enemy's trenches. Reprisal on the part of the enemy led to a tacit mutual abandonment of this plan. Moreover, the use, under any conditions, of pits, buckets, etc., in the first-line fire trenches led to results so disagreeable and even insanitary that the attempt, made for the sake of convenience, had also to be abandoned.

The only practicable solution of this important problem has been found in the system of disposal employed at present by the British, which is to use bomb-proof pits or dugouts leading out of the "communication" trenches. The position of these trenches and the associated pits will be readily understood by an inspection of the accompanying diagram (Fig. 1).

The ideal method, and one that is practicable in most cases, is to use, in the pits, individual buckets or tins with improvised handles, enclosed in simply constructed fly-proof boxes, or at least in boxes having a fly-proof lift-off seat, that will fit closely on the top of the pail. Lids should be made self-closing (Figs. 2 and 3). The pails when about two-thirds full are replaced by clean ones, and carried back by hand for final dispo-

sition of their contents. Fresh buckets are filled about one-quarter full with dilute cresol solution (1:360), after the internal surface has been rubbed with crude oil, when this is available. In some cases, especially when incineration of the contents of the buckets is to be carried out, sawdust, instead of cresol, to a depth of one-quarter to one-third, is employed, and the same material added by a scoop after each act of defecation — 100 pounds of sawdust per day per regiment will suffice. Whenever spillage occurs during removal, the soiled area should be treated at once with a 5 per cent. cresol solution. When possible to provide it, a concrete floor for the bomb-proof pit is a great improvement. Bomb-proofing usually means in this connection simply a sufficiently thick layer of earth between the roof of the excavation and the surface of the ground.

It naturally adds much to the efficiency of this system if the urine can be handled separately, particularly in incinerator methods. This is done in some cases by separate urine buckets, in others, as in the diagram (Fig. 4), by urine soakage pits. These are constructed by digging holes in the ground at a convenient place in the bomb-proof pit about 4 feet in each dimension, loosening the earth at the bottom, and then filling up with stones or perforated tin cans to near the top; a layer of brush or grass or sacking is placed over the stones, and the whole filled up with earth level with the surface of the ground. Funnels painted white, so they can be easily seen at night, may be built into the four corners of the urine pit, or a galvanized iron trough, conveniently situated to catch the urine, may be led into it (Fig. 4). Loose plugs of hay should be placed in the funnels, and with all soiled areas of the contiguous ground surface, as well as urine troughs when present, be treated with 5 per cent. cresol solution about twice daily.

The under as well as the upper surface of the above described box-seats should be swabbed with cresol. Cleaned buckets, cresol solution, sawdust, toilet paper, and other necessary materials are stored in a bomb-proof dugout situated off the communicating trench, conveniently near to the bucket and urine pits (Fig. 1).

As to final disposal, the buckets are carried back by hand and (1) buried, (2) incinerated in destructors, or (3) emptied into deep trench latrines. In any case

the buckets are at once cleaned, best over a concrete washing platform and with the aid of dilute cresol solution, followed by the use of dry sawdust and a stiff brush.

1. In disposition by burial, the contents of the buckets are emptied into a quartermaster's sanitary cart (*Anglice* tumbrel) and carted away to the reception area, where they are trenched into the ground daily and covered with not less than 12 inches of earth. Urine or sullage water is best treated separately by first passing it through a sedimentation tank, and then irrigating it out onto shallow furrows on the land selected, through wooden or earthenware channels. Pools should be avoided by feeding out the effluent as evenly as possible. The areas treated in this way are with difficulty kept in a sanitary condition with regard to flies and, in the thickly inhabited areas of northern France, are often hard to find available.

2. The ideal method of disposal, and that selected wherever practicable, is by incineration in some suitable form of destructor. This apparatus can also handle other forms of dry camp refuse which in addition serves as fuel. The British use successfully the Horsfall and the Meldrum types of destructors or some improvised modifications of them.

The unit or Horsfall portable destructor is constructed of iron walls with firebrick lining. It serves 1,000 men, if the urine has been previously drained away from the solids into a soak pit, and at an expenditure of not over 100 pounds of fuel per day. In this type of incinerator the furnace is separated from the bottom of the flue by a baffle plate, thus forming a combustion chamber in which the solid excreta are burned. This is the essential thing in the plan of this apparatus as, besides aiding combustion, offensive gases are thus oxidized and made inodorous. Very careful firing and stoking is necessary for its proper working, a supply of one half fecal matter and one half other refuse at each feeding giving the best results. The English Sanitary Notes (1916) state that improvised incinerators of the Horsfall type may be easily made with bricks or kerosene oil tins filled with ash and clay and wired together, the important thing being to be sure that a proper combustion chamber is provided.

The central or Meldrum type of destructor works on a larger scale and serves from 5,000 to 8,000 men. Being fixed and necessarily located farther back from

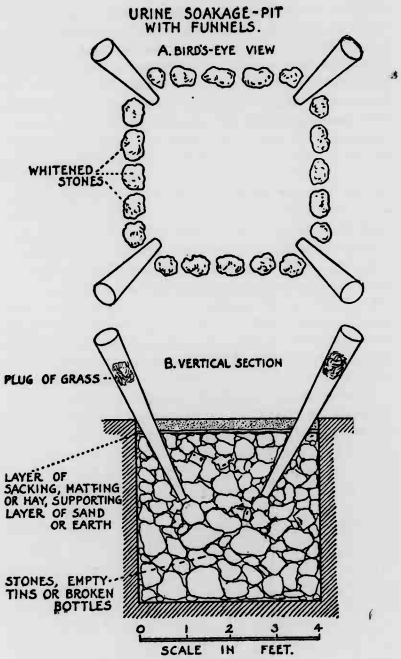
URINE SOAKAGE-PIT WITH FUNNELS.
A. BIRD'S-EYE VIEW
WHITENED STONES
B. VERTICAL SECTION
PLUG OF GRASS
LAYER OF SACKING, MATTING OR HAY, SUPPORTING LAYER OF SAND OR EARTH
STONES, EMPTY TINS OR BROKEN BOTTLES
0 1 2 3 4
SCALE IN FEET.

Fig. 4.—Urine soakage pit.

the front than the smaller Horsfall type, cartage of the buckets for part of the distance is required. A drying shelf over the fire is a very useful addition to the fixed incinerator. It is in these incinerator methods, as

stated above, that the sawdust is an especial improvement over the cresol solution for the pails.

The foregoing are of the closed types of incinerator. The open types, while easily adapted to ordinary refuse, are for obvious reasons extremely difficult if not impossible of application to the disposal of excreta.

3. In the use of the pit system of deep trench latrines for the final disposition of excreta on a large scale, holes are dug in a suitable place from 10 to 12 feet square and about 4½ feet deep. The English call this arrangement the "American oil-pit," and it is in fact a sort of compromise between the burial and incinerator methods just described. It is, I believe, the method now most used by the British. It certainly has the advantage of simplicity and can be made to work satisfactorily, if not perfectly, by proper supervision and care. Everything depends on the method of handling. A fly-proof cover is placed over the pit. The contents of the buckets brought back by hand from the bomb-proof pits in the communication trenches are emptied into the pit with kitchen and other camp refuse, including old tins which have previously been perforated. Urine is handled in this method by having a false bottom to the pit made of corrugated sheet iron, with numerous perforations through which the liquid material runs. In other cases the bottom of the trench is made to slope down toward a smaller and deeper pit on one side, into which the urine runs. Once a day, the fly-proof cover is removed from the trench, some hay or straw added, kerosene oil is poured over the material contained in the pit, and the whole burned over. The heat generated serves to evaporate the liquids. When the contents have reached within about 3 feet of the surface, the pit is filled in with earth and a new one dug.

Closely allied in principle to the subject of the disposal of human excreta is that of the disposition of horse manure, itself a vital question around army camps, on account of the enormous breeding of flies that always takes place, when some scientific and adequately administered plan of prevention is not carried out. The picket lines, which are, for convenience, nearly always in the immediate vicinity of camps, should be cleaned off carefully every day and the scrapings as well as gross manure removed. The lines should be burned over at least once a week with the aid of kerosene.

The difficult problem is to dispose of the manure thus collected. The ideal plan, and the one followed whenever practicable, is to burn it in specially designed incinerators. I have seen this satisfactorily done in the ordinary rock pile incinerators that we have used for some years past in the disposal of refuse in our American camps. Good results are difficult of accomplishment, however, and require much labor and care. Abroad, more elaborate methods have been put into practice, and though the construction of the required apparatus is more difficult than in the case of the rock-pile incinerator, the subsequent working is much easier and more economical.

One plan is to construct a wire frame or grid. This is of any required length, and is made in rectangular basket shape, the bed being 4 feet wide and 4 feet deep, and elevated about 2 feet above the surface of the ground. Any kind of wire may be used, such, for example, as that found binding up bundles of hay. The meshes of the trough or basket are about 5 inches square. The incinerator is set broadside to the prevailing winds. The bars at the bottom are made to run from side to side rather than longitudinally.

Another type of manure incinerator is a rectangular open brick pit, built like the former, above the ground. Its internal dimensions are from 9 to 10 feet each way, enclosed by a brick wall 9 inches thick and about 5 feet high. Air inlets are arranged below on the sides at the ground level, and are about 15 inches square. Just above these is laid a row of Decauville rails, turned with the flange up and about 3 inches apart, to form the grate bed.

Either of these devices burns manure quite effectively, with the aid of a little kerosene. To save fuel the manure should be first spread on an improvised drying platform, best built of concrete, situated alongside the incinerator.

In default of incinerators, manure should be carted as far as practicable away from camp and piled in a dump on firm, dry ground, according to the English method of "close packing." A compact rectangular block is the best shape, not over 5 feet high. Each new load of manure should be beaten down tightly with shovels into the sides of the heap, and the surface and sides treated by spraying with a solution of borax (¾ pound to 1 gallon of water). The whole

is finally covered over with about 12 inches of earth. The theory is that the heat developed by fermentation in the interior of a mass of this kind will prevent fly breeding by killing the larvae.

We thus attempt by the methods described above to attack the fly evil at its source; that is, to prevent breeding. Surprising results can be had by hard work and careful supervision. However, none of these plans in actual practice ever works quite perfectly. Some flies will get into the best managed camp, and even there we must attack them with zeal and the use of fly traps, sticky paper, poisoning (3 per cent. dilution of liquor formaldehydi in sweetened milk makes a bait attractive as well as destructive to flies) and the wire "swatter." The matter of screening I have already considered.

Animal carcasses, such as those of horses, are liable to cause great nuisance and must be suitably disposed of. The simplest method is to eviscerate the body and bury the entrails and other viscera. The remains of the animal are then covered over with hay or dry grass, a quart or so of kerosene is poured on, and the whole is set fire to. This does not usually accomplish complete incineration, but has the effect of sterilizing the surfaces of the ground as well as of the body, so that flies are not attracted and no particular nuisance results.

As to the disposal of human bodies, it is probable that, scientifically speaking at least, when they are in large numbers and in thickly settled areas, the method of incineration is most sanitary and generally satistory. A stone cairn is constructed, and on this alternate layers of bodies and wood are placed. Kerosene or tar is poured freely over the bodies and fuel and the whole set fire to. Combustion is usually efficacious and no further measures necessary. The method is said to have been used with success in Manchuria. The British, for sentimental reasons, have not adopted it in the present war, and I believe they have had no particular trouble in carrying out the usual methods of disposal by burial. It is extremely probable that we shall follow their example in this particular, though of the sanitary advantages of the cremation method there can be little doubt.

IV. PERSONAL CLEANLINESS

This question, always important in sanitation, and especially so in armies on account of the unavoidable crowding, takes on added importance in the present war, owing to the recently discovered fact that the body louse is the transmitting agent of typhus fever. The recent epidemic of this disease in Serbia will be readily recalled to mind, and it requires little stretching of the imagination to conceive of its possible introduction at any time on the western front.

In conditions such as prevail at present in northern France and Belgium it is, of course, impossible to banish the louse entirely; the attempt must be made, however, to reduce to the minimum this unpleasant and dangerous accompaniment of army camps under what amounts, in this respect, to siege conditions; hence the phrase, "delousing." Adequate personal cleanliness of body and clothing is the only preventive or, I should say, palliative for this pest. The individual can, no doubt, do a great deal along these lines to meliorate his own condition. Army sanitarians must also do everything possible to afford facilities for the necessary delousing, by wholesale, of the troops. This can be effected only by the establishment of divisional or other bathing plants for the soldiers, in connection with adequate facilities for the washing and disinfection of clothing on a large scale. I have recently described these matters in considerable detail elsewhere,[4] so I shall here pass them over with the mere mention of their great importance. The periodic examination of the men (at least once a week) to determine the fact of infestation by lice is of great value in this connection.

The personal use, besides frequent bathing, changing and washing of the clothing, of certain local applications has been found by the British to be quite effective. For killing adults, a powder known as the N. C. I. is dusted on the underclothing. This powder is composed of naphthalene, 96 parts; creosote, 2 parts, and iodoform, 2 parts; about two thirds ounce is required for each man. A special ointment has been found to have the effect of asphyxiating the young as they hatch out of the ova. This is rubbed into the interior seams of the various articles of clothing, in the

4. McCulloch, C. C.: South. Med. Jour., July, 1917.

quantity of about 1 ounce once a week. It is composed of crude mineral oil, 9 parts; soft soap, 5 parts, and water 1 part. The body, from the neck down, may also be anointed with this paste. A recent method said to be successful is to impregnate articles of underclothing by dipping and wringing them out in a solution of 1 per cent each of naphthalene and sulphur in benzene or gasoline. This is the English "antiparasitic vest," and it is not especially irritating to the skin.

It is not very difficult to free the person from lice by these methods, but early reinfection in the billets and quarters can hardly be prevented, so eternal vigilance is as necessary here as it is in the pursuit of political liberty.

Infected buildings and huts should be treated with two hours' exposure to sulphur dioxid fumigation by the Clayton apparatus. Clothing and blankets may be disinfected on a large scale in the same way. Scalding the underclothing and ironing the seams of the outer clothing with a hot flatiron is sometimes quite effective, in default of more thorough methods.

It may be well to add a brief account of a few of the simpler methods of field disinfection in actual use abroad.

1. There is the portable emergency steam apparatus known as the Thresh disinfector. Its principle is that of the modern steam disinfector, that is, it has a central chamber into which the articles to be treated are placed and through which the current of steam flows, surrounded by an outer chamber or jacket, into which steam is first admitted and which serves to prevent condensation and loss of heat. Infected articles are put in at one end of the apparatus and after treatment are taken out sterilized at the other end to avoid subsequent contamination at the sterilizer itself. Steam at ordinary atmospheric pressure, evolved from a concentrated saline solution, is used in the field apparatus and is safe and adequate for practical purposes. Half an hour's exposure is sufficient, and the usual sized apparatus will accommodate sixty blankets, or their equivalent in clothing, at each charge. By using a sufficient number of these disinfectors, it is quite possible to supply an installation that will cover the large amount of work required in connection with the modern elaborate plants for divisional baths.

2. The field box disinfector works on the same principle, but is much simpler than the Thresh apparatus. It consists of a jacketed metal box, with openings at top and bottom through which there is conducted steam generated in a separate metal boiler, heated over an improvised stone furnace. The only disadvantage of this apparatus is its rather small capacity.

3. The so-called "Serbian barrel" is an improvisation that has been much used and with good results on the British front in Belgium. The bottom end of a barrel is perforated with holes, and the top replaced by a flat metal lid, weighted down so as to fit tightly. Sandbag collars are wound around the top and bottom of the barrel, to retain the steam; the whole being then placed over a metal boiler; and this in turn rests on a brick or improvised adobe furnace, which has a flue at one end. The barrels with separate boilers are often set in series over a long narrow furnace. A container of 60 gallons capacity will handle seven blankets at a time. As many as eighty of these Serbian barrels have been used at one time in a divisional bathing plant, where the Thresh disinfectors were not available.

V. THE PREVENTION OF SPECIAL DISEASES

We have in the army, in addition to the practice of the general sanitation of the troops in regard to food and water, conservancy, personal habits, etc., often to concern ourselves with efforts toward the prevention of certain diseases common in military life, some of them especially likely to occur under particular conditions of environment. Each camp, each war and each climate has had its own individual situation in this respect to be studied and handled by the military sanitarian. The European war, like the others, has developed its own characteristic liability to particular diseases.

Let us look for a moment at the development of the war in regard to a few of the most important and interesting of these diseases. They are no doubt familiar to most physicians, through the reading of the current medical journals, but for the sake of completeness I shall consider them briefly here.

In the consideration of the prevention of diseases in war, two points, always important in the study of

disease, but especially so in military life, ought to be emphasized at the start. These are:

1. *Accurate Diagnosis.* — This statement at first glance would seem to be a sort of medical truism and unnecessary to repeat. However, when one recalls that in 1898, in our Spanish war, the doctors mistook a large proportion of the typhoid fever for malaria, with the result of great sanitary disaster, it seems just as well to bring it up again in this connection. No doubt we shall have better facilities for diagnosis in this war. The British have developed the field laboratory idea in a practical way. Before billeting troops in new areas or occupying ground recently captured from the enemy, they send out traveling motor laboratories in advance of the troops. These have been found necessary, especially on account of the German practice of poisoning wells. Metallic poisons are tested for and the water examined chemically and bacteriologically for gross pollution.

2. *Correct Statistics.*—For good preventive work, the army sanitarian must have reliable information as to the incidence of the various infectious diseases, the numbers of sick, and the geographic distribution in camps, regiments, etc. Statistics, indeed, are the necessary foundation for all effective sanitary work. However, the importance of this feature of the work is not always realized by the neophyte in practical sanitation. It affords a good example of the necessity of having experienced medicomilitary administrators in control of medical department affairs, and of the need of special training along these lines for recently appointed medical officers. Paper work and "red tape" are a great nuisance in the army, especially to new men, and ought to be cut down as far as possible. A certain amount of bookkeeping, however, is absolutely essential here, as in all well conducted business affairs in civil life. As another important example of this necessity, it should be realized that the enormous matter of the pensions that succeed a big war, or any large enrolment of men in the military service, even without fighting, has its foundation stone in the medical records of the period in question. Justice, both to the individual soldier and to his family on the one hand, and to succeeding generations of our tax-paying descendants on the other, absolutely requires the most intelligent and painstaking care in

the preparation of medical records. As good sanitary work may, by prevention and elimination of epidemics, forestall the necessity for tens of thousands of pension claims, so also good medical administration may by prompt removal of wounded from the battle front, and quick return of well handled soldiers to the firing line, aid the military commander, as much as any other factor, in winning his country's battles. Our military men have not always recognized this fact, but I believe that at least in the regular army they are fast coming to appreciate the immense value to their work of the competent medical staff officer. Lord Northcliffe[5] has written in a most complimentary way of the administrative work of the Royal Army Medical Corps in this war. We learn from Colonel Goodwin that the British line officers now follow implicitly the sanitary advice of their medical staff, a consummation devoutly to be wished for in the new American army.

IMPORTANT DISEASE PROBLEMS

Among the more important disease problems of the present war are those afforded by:

1. *Typhoid and Paratyphoid Fevers.*—The practice of compulsory antityphoid vaccination has doubtless solved successfully for us the formerly serious question of typhoid fever in our army camps. The British have had some trouble in the present war owing to the fact that vaccination is voluntary in their army. Fortunately, however, owing to careful sanitation, the disease did not make great inroads on their fighting strength.

The place of typhoid as a military problem has now been taken for us by paratyphoid fever. Many of the milder cases diagnosed as typhoid fever in 1898 were no doubt paratyphoid infections, differentiation between the two diseases not having been made at that early date by the practicing physician. In fact, paratyphoid as a distinct disease entity was not known at all until 1896, when it was announced by Achard and Bensaude.[6] Glimmerings of the truth had, indeed, been seen earlier. Osler's statement of his belief that there were undifferentiated continued fevers in the South was no doubt a stimulus to the army surgeons,

5. Saturday Evening Post, Philadelphia, April 28, 1917.
6. Achard, C., and Bensaude, R.: Bull. et mém. Soc. méd. d. hôp. de Paris, 1896, pp. 821-833.

who, especially in Texas, made observations in this connection. Col. William B. Davis noted at Fort Clark, Texas, in 1892, "a hybrid between typhoid and malaria," and in 1894 I[7] described the symptomatology of a continued fever noted at various border posts, which I tried to differentiate from typhoid. We called this "Texas fever" in default of a better name, and I was inclined at that time, following Guiteras, to regard it as of thermic etiology. I was mistaken in this, and Davis made a better guess. I have no doubt, at present, that the disease observed in Texas was what we now call paratyphoid fever, though, doubtless from imperfect observation, I missed the "rose spots," which it seems should be found in at least 50 per cent. of cases of paratyphoid.

Reverting to present conditions, it seems that inoculation with a mixed vaccine of paratyphoid, types A and B, has prophylactic value against the disease. In fact, this measure has been used successfully both in Europe and in our camps on the Mexican border, where paratyphoid has recently been found to exist bacteriologically as well as clinically. Our troops in this war will therefore doubtless be vaccinated against paratyphoid fever as well as against typhoid. There is a rather severe reaction after inoculation with the paratyphoid B strain, but the British experience is that this is not serious enough to counteract its great value as a prophylactic.

The other intestinal infections, besides the continued fevers, are at present handled in a preventive way only by the ordinary methods of camp hygiene. Possibly something practical in a specific way may result in the future from the prophylactic administration of emetin in amebic dysentery and the development of the Japanese idea of vaccine or serum prophylaxis of the bacillary form, though it has not up to the present. It seems to me that this question of bacillary dysentery offers the best and most to be desired field for future research and experiment in preventive medicine, in connection with the needs of the army. If intestinal diseases could be excluded, army sanitation would be, to speak in the vernacular, almost "a cinch." It is worthy of note in this connection that raw vegetables

7. McCulloch, C. C.: Rep. Surg.-Gen., U. S. Army, Washington, D. C., 1894, pp. 52-58.

seemed in the Philippines a potent means of the conveyance of dysentery and other intestinal diseases.

2. *Tetanus.*—This clinically hopeless and distressing affection gave rise to much trouble and mortality among the wounded in the early period of the war. It was found to be much more extensively present in the thickly settled areas, such as the Champagne district in France, than in more sparsely inhabited places—a question of soil pollution. It will suffice to say in this connection that a completely adequate solution of the tetanus problem has now been found: All victims of wounds of whatever character, simple scratches included, are given at the earliest possible moment after the receipt of the wound a prophylactic subcutaneous injection of 500 U. S. Army units of tetanus antitoxin contained in about 3 c.c. of horse serum; in the case of severe wounds, a second dose of the same strength is given on arrival at the base hospital. The first injection is given preferably at a dressing station or field ambulance, as soon as possible after removal of the wounded man from the firing line. When given in the small doses of serum stated above, the danger of anaphylaxis from the second or succeeding injections is negligible. This measure has entirely controlled the former troublesome situation, and tetanus is no longer feared by the surgeon.

3. *Infection with Gas-Forming Bacilli.* — This unpleasant and often dangerous complication of wounds, also owing to soil infection in the thickly populated and agriculturally worked-over sections of the battlefields of Belgium and France, has given rise to most serious trouble. Most of these infections are due to the *Bacillus aerogenes-capsulatus* of Welch, usually called, by the British, *B. perfringens.* About the only means available to us in prophylaxis is the attempt to minimize the influence of the predisposing causes of gas cellulitis or gas gangrene. These causes are the too tight bandaging of the limb, the too infrequent changing of dressings, and the lack of adequate drainage of wounds. I understand that an antitoxin has just been prepared for this bacillus. Let us hope that it will prove to have prophylactic as well as curative value. This is a surgical rather than a medical or hygienic matter, but it seems worthy of note in this place.

4. *"Trench Foot" and Frostbite.*—This particular effect of prolonged exposure to the cold and wet on dependent limbs had not been observed before the present war—certainly not on a large scale. The symptoms, speaking generally, rather closely resemble those of a preliminary peripheral neuritis, succeeded in severe or improperly treated cases by pressure gangrene, the successive pathologic stages being in the latter case, first, stasis, second, exudation, and third, gangrene. Rational measures of prophylaxis have been found to be:

(*a*) Drainage of the trenches by the military engineers, or, this being impracticable, the raising of the foot level in the trenches by fascines of brushwood.

(*b*) The thorough rubbing into the feet and legs of whale oil or antifrostbite grease.

(*c*) The wearing of long rubber boots. In any case the avoidance of pressure by tight shoes or puttees. The socks should be kept dry (by greasing the shoes) and changed daily.

(*d*) Keeping the legs elevated while resting, and the avoidance of the sitting posture in sleeping.

(*e*) Keeping up the physical condition of the soldiers by proper nourishment and warmth (as far as possible) and the avoidance of fatigue. Basil Hughes recommends the frequent use of hot soup and also the rum ration in selected cases.

Dampness in gun emplacements is a fertile cause of bronchitic and rheumatic affections, and should be obviated by care in construction. Water should be drained to the outside of the "cave," rather than under the floor, or it should be periodically pumped out. Walls are made double and filled with sand or brushwood and iron sheathing is incorporated in the earth covering of the emplacement.

5. *Trench Fever.*—This disease is another of the developments of the peculiar environmental conditions of the war in Europe. Briefly, the symptoms are those of a relapsing pyrexia extending over a time varying from a few days to several weeks, usually coming on suddenly with headache and pain in the back and legs, and having no specially characteristic features beyond these and painful, tender shins. It thus resembles the European relapsing fever, though as yet no spirochetes have been found in the blood. Suspicion points to its

conveyance by the body louse, and rational prophylaxis would therefore point, as in typhus fever, to measures chiefly directed against these vermin — to isolation of patients, the disinfection of clothing and the protection against lice of the attendants on the sick. The internal administration of quinin has been recently suggested as a prophylactic in typhus fever.

6. *Gas Poisoning.*—This remarkable German contribution to warfare was a great surprise to the Allies when first sprung on them, and a great many men were "gassed" in the early stages of its employment with distressing and often fatal results, generally due to asphyxia in those not killed at once by the poison. Prevention was quickly stimulated, however, and gas masks and gas helmets were devised which, saturated with certain chemicals, served to neutralize or nullify the bad effects both of the "shell" and "drift" gases used by the enemy. It is hardly worth while to speculate on the chemical composition of the various gases and their antidotes, as the different armies have vied with each other in their production, and keep them as strict military secrets. It suffices for our present purposes to know that all soldiers in the trenches are furnished with the proper masks and taught how and when to use them, and that at present it has resulted that the gas attacks are no longer feared and seldom do any really serious damage.

7. *Cerebrospinal Fever.*—Outbreaks of this rather mysterious affection are quite common in army camps. Infectibility, though it appears to be slight, is not negligible, and it seems probable from later experience that, owing to defective knowledge of its means of spreading, we have not perhaps, in the past, been quite so strenuous in our prophylactic measures as we should have been. Today, whether rightly or wrongly it is difficult to say, we think it advisable to act on the "carrier" theory of the propagation of the disease. Adequate ventilation appears to be essential. We now isolate patients, and contacts, as far as possible, examining the latter bacteriologically to try to determine whether or not they may be possible carriers; we disinfect bedding and other fomites; we destroy food and waste matter in infected premises. The throats of carriers are swabbed with 3 per cent. iodin in glycerin or some equivalent solution, or spray is used as an alternative. As it is thought possible that flies

may act as vectors, they and their breeding places are attacked *secundum artem.* Munson[8] has written convincingly in regard to the prevention of the spread of diseases conveyed by means of the secretions of the nose and throat, taking measles as a text. He emphasizes the importance of ventilation, of fresh air and of sunshine. I am also inclined to follow Wells of Chicago, who says that pneumonia (and other respiratory infectious diseases) could be largely controlled by the popularization of the use of the pocket handkerchief, that is, holding it over the nose and mouth whenever sneezing or coughing. This plan does not seem impossible of realization when we consider the success of the educational campaign of recent years against promiscuous expectoration.

8. *Malaria.*—Owing to the ubiquitous nature of the *Anopheles* mosquito, troops in the field are in most countries exposed at times to malarial infection. This, while not usually dangerous to life in temperate climates, can nevertheless by its effect on the sick reports often become quite troublesome to armies in campaign. It behooves us, therefore, to be awake to the possibility, and in malarious locations, to employ the accepted methods of prophylaxis. The temporary nature of army occupation makes it generally impossible to carry out all the painstaking methods that were employed, for instance, at Panama; still, a great deal can often be done by simple and easily employed means of prevention. The use of the mosquito bar and head net at night (with at least eighteen meshes to the inch) should be employed in camps liable to malarial infection; small pools should be filled in and larger collections of water carefully oiled weekly by spraying (1 ounce of kerosene to each 16 square feet of surface), or treated continuously by a drip can; water tanks should be screened, and old tins, bottles, etc., looked after. The application, on exposed parts of the body, of the essential oils gives some help, though not reliable alone, and something may be done by "swatting" adults locally. The administration of 6 grains of quinin daily proved to be a prophylactic of value in the antimalarial work on the Panama Canal.

8. Munson: Mil. Surg., June, 1917.

Owing to our adequate modern methods of quarantine, *cholera* and *plague*, formerly so much dreaded in camps and wars, are not at all likely to be introduced on the western battle front. If they should by any chance get a foothold, the resulting conditions would most likely prove to be serious. The crowding, on the one hand, and on the other the enormous numbers of rats that are present in the trenches and billets, would make the proper prophylactic efforts very difficult of execution. In the event of the introduction of either of these diseases, I am inclined to believe that the sanitary authorities would promptly try the effect of prophylactic vaccination, for the reason that while the efficacy of this procedure is not fully proved on a large scale, still it has given promise of good results. In addition, the already well established preventive methods of control would, of course, be employed, as they have been so often and so successfully in both hemispheres by the officers of our distinguished Public Health Service.

CONCLUSION

I wish to repeat that this sketch is not by any means intended to cover all the ground of military medicine, and all the diseases of camps and armies; this could not be done, indeed, in the space of any journal article, however concise. I have, however, tried to outline briefly the essential points in the prophylaxis of the most frequent and important diseases that we are likely to encounter on the western front in Europe, particularly those that seem to be in some respects newer developments of the peculiar environmental conditions of the present war.

Even this "indication" has, I am too keenly aware, been imperfectly handled. I shall be amply satisfied, however, if I am successful in arousing the interest of some of our prospective young medical officers in the sanitary aspects of the war and in stimulating them to further study of the literature (cited above) of this so important and timely subject.

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